Amendments to the Specification

Applicant has carefully reviewed and edited the entire specification for accuracy and consistency of terminology and grammar. Applicant has also corrected a number of typos. In addition, Applicant has made several amendments to the specification to conform the written description to the drawings and vice versa. The title has been amended to more particularly identify the claimed subject matter. No new matter has been added by way of these amendments to the specification.

Amendments to Claims 1-30

Claims 1-2, 12-13, 15-17 and 25 were indicated by the Examiner to be allowable if rewritten or amended to overcome the rejections under 35 USC §112, second paragraph, set forth in the Office Action. Claims 1-2, 12-13, 15-17 and 25 have been amended accordingly. In addition, substantive amendments have also been made.

In addition, original claims 3-11, 14, 18-24, and 26-30 have been voluntarily amended.

The specific amendments to claim 1-30 will now be discussed.

In claim 1, as well as in all other applicable claims, "heat-producing" has been substituted for "heat producing". Further in claim 1, as well as other affected claims 3-12, the word "device" has been replaced by "assembly". The phrases "disposed on the substrate and soldered to the substrate" and the language "and thermally bonded to the heat sink" have been deleted. The phrase "attached to the substrate, wherein the heat sink is disposed over the at least one heat-producing component and the substrate, wherein the heat- producing component is" has been added. Furthermore, in claim 1, the language "wherein a thermal interface material is disposed between the heat sink and the heat-producing component to bond the heat sink to the heat-producing component, and wherein the at least one mounting pin of the heat sink is soldered to the substrate" has been added. Support for disposing the "thermal interface material" between the "heat sink and the heat-producing component" may be found in the original specification on page 6, lines 16-19 and in Figures 9-12. Support for soldering the "at least one mounting pin of the heat sink" to the substrate may be found in the original specification on page 4, lines 9-16.

In claim 2, the language "to receive the at least one mounting pin, wherein the at least one

mounting pin is disposed in the at least one mounting hole and wave-soldered to attach the heat sink to the substrate and to preheat and bond the heat sink to the heat-producing component with the disposed thermal interface material" has been added. The language "therein, wherein the at least one mounting pin is adapted to be disposed through the at least one mounting hole is the substrate, wherein the heat sink is further attached to the substrate by disposing the pin through the hole and soldering the pin to the substrate during the pre-assembly operation" has been deleted.

In claim 3, the dependency has been switched from claim 1 to claim 2. The word "being" has been substituted for "is". The word "mounting" has been inserted before "pin" in this claim, as well as in all other affected claims. The language "thermally conductive" and "and the at least one mounting hole" have been added. Also, in claims 3, the language "such that at least one pin can be soldered to the substrate when the thermally conductive plate is coupled to the back side of the heat-producing component" has been deleted.

In claim 4, the dependency has been switched from claim 2 to claim 3. The language "thermally conductive" has been inserted before "plate" in this claim, as well as in all other affected claims.

In claim 5, the dependency has been switched from claim 3 to claim 4.

In claim 6, the language "further comprising: a" has been replaced by the word "wherein". Also, in claim 6, the language "to reduce thermal resistance between the back side of the heat-producing component and the heat sink" has been deleted.

In claim 7, the words "a" have been added (two occurrences).

In claim 8, the language "electrically and/or mechanically" has been inserted before "attached". The language "of the heat-producing component" has been added. The phrase "comprises: electrically and/or mechanically coupling the front side to the substrate" has been deleted.

In claims 9, 21, and 28, the language "and other such materials suitable for dissipating heat away from the heat source" has been deleted for indefiniteness.

In claim 12, the dependency has been switched from claim 1 to claim 2. Also, the phrase "the at least one mounting pin is disposed in the at least one mounting hole and wave-soldered

during a pre-assembly operation" has been substituted for the phrase "soldering the at least one pin in the at least one hole to enhance heat dissipation from the heat sink, comprises: wave soldering the at least one pin disposed in the corresponding at least one hole in the substrate to mechanically couple the heat sink to the substrate during the pre-assembly operation to dissipate heat from the heat producing component".

In claim 13, the preamble phrase "of assembling an electronic device" has been deleted. Also, the phrase "such that the thermal interface material is disposed on the substrate" has been deleted. In addition, the phrase "pre-heater of a wave soldering machine" has been substituted for the phrase "wave soldering preheater". Furthermore, the word "heat" has been inserted in front of the word "sink".

In claim 14, the word "using" has been substituted for "in", and the word "heat-producing" has been inserted in front of the word "component".

In claim 15, the words "at least one mounting" have been inserted in front of the word "pin", and the phrase "and to further lock in the thermal coupling established between the heat producing component and the heat sink during the pre-heating" has been deleted.

In claim 16, the language "to receive the at least one mounting pin of the heat sink" has been added, and the language "wherein the at least one pin is disposed through the corresponding hole in the substrate for wave soldering the pin to the substrate"has been deleted.

In claim 17, an additional process step has been added by the language "disposing the at least one mounting pin of the heat sink through a corresponding at least one hole in the substrate". In addition, the phrase "to mechanically attach the heat sink to the substrate, and to further lock in the thermal coupling established between the heat producing component and the heat sink while the thermal interface material is still hot" has been deleted.

In claim 18, the dependency has been switched from claim 16 to claim 13.

In claims 22 and 29, the word "temperatures" have been replaced by the word "temperature".

In claim 23, the dependency has been switched from claim 22 to claim 13.

In claim 25, the preamble phrase "of assembling an electronic device" has been deleted. Also, in claim 25, the language "at least one mounting pin" has been substituted for "each of the

mount pins". Also, the language "using a wave soldering process to cause the thermal interface material to wet and bond the heat sink and the heat-producing component and to solder the at least one mounting pin to the at least one mounting hole" has been substituted for the original last paragraph.

In claim 26, the word " including" has been replaced by "to have", and the language "such that" has been replaced by the word "wherein".

In claim 27, the word "such" and the phrase "the heat exchange portion" have been deleted. Also, the language "is disposed" has been inserted.

In claim 28, "materials" has been substituted for "a material".

All of the above-mentioned amendments to claims 1-30 are supported by the application as originally filed. No new matter has been added. All of the claims indicated as allowed or allowable should still be found to be allowable over the art of record, and an indication to such effect is respectfully requested.

Rejections under 35 U.S.C.§112

Claims 1-2, 12-13, 15-17, and 25 were rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

As indicated above, Applicant has amended claims 1-2, 12-13, 15-17, and 25 accordingly.

Therefore, Applicant respectfully requests that the rejection of claims 1-2, 12-13, 15-17, and 25 under 35 U.S.C.§112, second paragraph, be withdrawn, and that such claims be allowed.

Rejections under 35 U.S.C.§102(b)

Claims 1-2, 4, and 9-12 were rejected under 35 USC §102(b) as being clearly anticipated by McGaha et al. (U.S. Patent No. 5,311,395).

Claims 1-5 and 8-12 were rejected under 35 USC §102(b) as being clearly anticipated by Wilens (U.S. Patent No. 4,605,058).

Claims 1, 3, and 6-11 were rejected under 35 USC §102(b) as being clearly anticipated by Funari et al. (U.S. Patent No. 4,849,856).

Independent claim 1 is respectfully asserted to distinguish over the McGaha, Wilens, and Funari references. None of these references disclose *inter alia* a thermal interface material disposed between the heat sink and the heat-producing component to bond the heat sink to the heat-producing component, as recited in amended claim 1.

For this reason, claim 1 should be found to be allowable over the McGaha, Wilens, and Funari references. Moreover, Applicant considers additional elements and limitations of claim 1 to further distinguish over the cited references, and Applicant reserves the right to present arguments to this effect at a later date.

Claims 2-12, which depend directly or indirectly from claim 1 and incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Applicant respectfully requests that the rejection of claims 1-12 under 35 U.S.C.§102(b) as clearly anticipated by McGaha, Wilens, or Funari be withdrawn, and that claims 1-12 be allowed.

Allowable Subject Matter

Applicant notes with appreciation the allowance of claims 14, 18-24, and 26-30. Claims 14, 18-24, and 26-30 have been voluntarily amended to satisfy Applicant's preferences, not necessarily to satisfy any legal requirement(s) of the patent laws, and such amendments are not intended to limit the scope of equivalents to which any claim element may be entitled.

Claims 13, 15-17, and 25 were indicated to be allowable if rewritten or amended to overcome the rejections under 35 USC §112, second paragraph, set forth in the Office Action. Claims 13, 15-17, and 25 have been amended accordingly.

All of the above-mentioned amendments to the claims are supported by the disclosure. No new matter has been added. Claims 13-30 should therefore still be found to be allowable over the art of record, and the Examiner's indication to that effect is respectfully requested.

Conclusion

Applicant respectfully submits that claims 1-30 are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney Kash Nama at 603-888-7958 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

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Date October 3, 2002 By Ann M. McCrackin

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Jane E. Brockschink
Name

Jane E. Brockschink
Signature

OCT 0 8 2002

CLEAN VERSION OF AMENDED SPECIFICATION PARAGRAPHS

ELECTRONIC ASSEMBLY WITH SOLDERABLE HEAT SINK AND METHODS OF MANUFACTURE
Applicant: George Hsieh
Serial No.: 09/897,320

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The paragraph beginning at page 1, line 6.

Embodiments of this invention relate generally to printed circuit boards and components coupled thereto and, in particular, to an electronic assembly with solderable heat sinks and methods of manufacture.

The paragraph beginning at page 1, line 23.

Heat sinks have been used to assist in dissipating heat from the processor and other heat-producing components within a housing. However, the overall size of the heat sink is limited by the volume constraints of the housing, and the footprint and/or the size constraints. Heat dissipation has been increased by using fasteners such as mechanical clips, epoxy, glue, and/or rivets which physically hold a heat sink to the processor package mounted on a printed circuit board. For some heat sinks, spring-loaded fasteners are used to couple the heat sink with the heat-producing components to enhance heat dissipation from the heat-producing components. However, such fasteners require one or more additional final assembly process steps, which results in requiring additional manufacturing resources after all of the soldering steps are completed. These additional manufacturing steps increase the cost of providing a thermal solution to heat-producing components such as chipsets.

The paragraph beginning at page 2, line 5.

Figures 1, 2, 3, and 4 illustrate conventional manners 100, 200, 300, and 400, respectively, of coupling the heat sink to heat-producing components such as chipsets and/or microprocessors. Figure 1 illustrates using a mechanical clip 110 to couple heat sink 120 to heat-producing component 130 mounted on a printed circuit board 140 to enhance heat dissipation from the heat-producing component 130. Figure 2 illustrates using epoxy and/or glue 210 to couple heat sink 120 to heat-producing component 130. Figure 3 illustrates using spring-loaded fastener 310 to couple heat sink 120 to heat-producing component 130. Figure 4 illustrates using

rivets 410 to couple heat sink 120 to heat-producing component 130. All of these prior art techniques require one or more additional final assembly process steps, which increases the cost of providing a thermal solution to heat-producing components. In addition, the prior art techniques illustrated in Figures 1, 3, and, 4 require substantial circuit board space to mechanically retain the heat sink in place.

The paragraph beginning at page 2, line 18.

For the reasons stated above, and for other reasons stated below which will become apparent to those skilled in the art upon reading and understanding the present specification, there is a need in the art for a low-cost technique that consumes substantially less circuit board space than the prior art techniques to provide a low-cost thermal solution to the heat-producing components.

The paragraph beginning at page 2, line 25.

Figures 1, 2, 3, and 4 illustrate prior art techniques of coupling heat sinks to heat-producing components mounted on a printed circuit board.

The paragraph beginning at page 2, line 27.

Figures 5, 6, 7, and 8 illustrate perspective views of different example embodiments of heat sinks according to the embodiments of the present invention.

The paragraph beginning at page 3, line 1.

Figures 9, 10, 11, and 12 illustrate a process for assembling an electronic assembly using the heat sinks shown in Figures 5, 6, 7, and 8 according to an embodiment of the present invention.

The paragraph beginning at page 3, line 4.

Figures 13, 14, and15 illustrate an exemplary electronic assembly formed from the process shown in Figures 9, 10, 11, and 12.

The paragraph beginning at page 3, line 6.

Figures 16 and 17 illustrate the coverage/wetting of a thermal interface material between a heat sink and a heat-producing component after passing through wave soldering pre-heaters.

The paragraph beginning at page 3, line 11.

In the following detailed description of the embodiments, reference is made to the accompanying drawings that illustrate embodiments of the present invention and its practice. In the drawings, like numerals describe substantially similar components throughout the several views. These embodiments are described in sufficient detail to enable those skilled in the art to practice them. Other embodiments may be utilized, and structural, logical, and electrical changes may be made without departing from the scope of the present disclosure. Moreover, it is to be understood that the various embodiments of the invention, although different, are not necessarily mutually exclusive. For example, a particular feature, structure, or characteristic described in one embodiment may be included in other embodiments. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of embodiments of the present invention are defined only by the appended claims, along with the full scope of equivalents to which such claims are entitled.

The paragraph beginning at page 3, line 24.

This document describes, among other things, a low-cost technique that consumes less circuit board space than traditional means for providing a chipset thermal solution.

The paragraph beginning at page 3, line 27.

Figures 5, 6, 7, and 8 illustrate perspective views of different example embodiments of heat sinks 500, 600, 700, and 800, respectively, according to embodiments of the present invention. Figure 5 illustrates a perspective view of one example embodiment of a heat sink 500. As shown in Figure 5, heat sink 500 includes two mounting pins 510 and a thermally conductive plate 520. In some embodiments, heat sink 500 can include at least one mounting pin. The mounting pins 510 are adapted to be disposed through corresponding mounting holes in a substrate (not shown) such that when heat sink 500 is thermally coupled to a heat-producing component (not shown), the mounting pins 510 are disposed through the holes for soldering the mounting pins 510 in the holes for mechanically attaching the heat sink 500 to a substrate during pre-assembly operation to provide a low-cost thermal solution. In some embodiments, the heat sink 500 can include multiple mounting pins and corresponding multiple mounting holes in the substrate.

The paragraph beginning at page 4, line 9.

In some embodiments, the mounting pins extend beyond the thermally conductive plate 520 such that the mounting pins 510 can be soldered when the thermally conductive plate 520 is thermally coupled to a heat-producing component. The heat sink 500 can be made from materials such as copper, aluminum, and other such materials suitable for dissipating the heat from a heat-producing component. In some embodiments, the mounting pins 510 can be soldered to the substrate using processes such as wave soldering, surface mount soldering, and other such soldering processes. In some embodiments, mounting pins can comprise two or more wave solderable pins.

The paragraph beginning at page 4, line 17.

Figure 6 illustrates a perspective view of another example embodiment of a heat sink 600 according to the present subject matter. The heat sink 600 shown in Figure 6 is similar to heat sink 500 shown in Figure 5 except that heat sink 600 shown in Figure 6 further includes a heat

exchange portion 610 disposed across from the mounting pins 510. In some embodiments, the heat exchange portion 610 includes multiple fins that extend upwardly beyond the thermally conductive plate 520.

The paragraph beginning at page 4, line 23.

Figures 7 and 8 illustrate perspective isometric views of other example embodiments of heat sinks 700 and 800, respectively, according to the present subject matter. The heat sinks 700 and 800 are similar to heat sinks 500 and 600 shown in Figures 5 and 6, respectively, except that heat sinks 700 and 800 include four mounting pins instead of the two mounting pins shown in Figures 5 and 6. Also, the thermally conductive plate 710 is configured to include the four mounting pins as shown in Figures 7 and 8.

The paragraph beginning at page 4, line 29.

Figures 9, 10, 11, and 12 illustrate one example embodiment of process actions 900, 1000, 1110, and 1210, respectively, for attaching at least one heat-producing component 130 mounted on a printed circuit board 140 to a heat sink such as heat sink 600 shown in Figure 6.

The paragraph beginning at page 5, line 4.

Action 900, as shown in Figure 9, begins with mounting a front side 930 of the heat-producing component 130 to the printed circuit board (also referred to as a "substrate" herein) 140. The substrate 140 also includes multiple holes 950. In some embodiments, mounting the heat-producing component 130 includes electrically and/or mechanically coupling the component 130 to the substrate 140. The heat-producing component 130 includes integrated circuit devices such as a chipset, a microprocessor, a digital signal processor, and/or an application-specific integrated circuit device.

The paragraph beginning at page 5, line 11.

In addition, action 900 as shown in Figure 9 also includes positioning a layer of thermal interface material 910 onto a back side 940 of the heat-producing component 130. The back side 940 of the heat-producing component 130 is disposed across from the front side 930. In some embodiments, thermal interface material 910 is either a phase change thermal interface material, such as Chomerics T725, Chomerics 705, Chomerics 710, and/or Chomerics 454, or a thermal grease such as Thermalloy TC1, Shinetsu G749, and/or Shinetsu G750. While the thermal greases, such as Shinetsu G749 and Shinetsu G750, are in liquid (*viscous*) form at room temperature, the phase change thermal materials, such as Chomerics T725, Chomerics 705, Chomerics 710, and Chomerics 454, are in a soft solid paste form at room temperature that melts with heating. These thermal interface materials melt at typical wave-soldering temperatures. Generally, the phase transition (changing from a paste-like state to a liquid state) temperatures of these phase change thermal interface materials are around 55^0C - 65^0C. Typically the ambient temperatures inside wave soldering machines (around the pre-heaters and the solder wave chambers) are well above 70^0C. Temperatures above 70^0C are generally sufficient to melt the above-mentioned phase change thermal interface materials. Action 900 is compatible with use of either of the above-mentioned thermal interface materials.

The paragraph beginning at page 5, line 29.

Action 900, as shown in Figure 9, further includes aligning heat sink 600 including at least one mounting pin 510 over the thermal interface material 910 and further through the corresponding at least one hole 950 in the substrate 140 so that the mounting pins 510 can be wave-soldered to the substrate 140. It can also be envisioned that the mounting pins 510 can be designed to be soldered to the substrate 140 using other circuit board assembly techniques, such as pin-in-paste, surface mount, and other methods suitable for attaching the heat sink 600 to the heat-producing component 130 during pre-assembly operations.

The paragraph beginning at page 6, line 7.

In some embodiments (refer to Figures 5 and 6), the heat sink 600 is formed to include a thermally conductive plate 520 such that the mounting pins 510 extend beyond the thermally conductive plate 520. In some embodiments, the heat sink 600 is formed to further include a heat exchange portion 610 (refer to Figure 6), which extends outwardly from the plate 520. The heat exchange portion 610 is formed such that the heat exchange portion 610 is disposed across from (i.e. on an opposite side from) the heat-producing component. In some embodiments, forming the heat exchange portion 610 includes forming multiple fins that extend away from the thermally conductive plate 520. The heat sink 600 is made from materials such as copper, aluminum, and other such materials suitable for dissipating heat away from the heat source.

The paragraph beginning at page 6, line 16.

Action 1000, as shown in Figure 10, includes reducing the viscosity of the thermal interface material 910 by preheating 1010 the thermal interface material 910 in a wave soldering pre-heater to cause the thermal interface material 910 to wet the heat-producing component 130 to thermally couple the heat sink 600 to the heat-producing component 130. In some embodiments, reducing the viscosity of the thermal interface material 910 further includes loading the substrate 140, including the heat-producing component 130, thermal interface material 910, and the heat sink 600 onto a conveyor of a wave soldering machine (not shown) and reducing the viscosity of the thermal interface material 910 by preheating (represented by wavy arrows 1010) the thermal interface material 910 disposed between the back side 940 of the heat-producing component 130 and the heat sink 600 such that the thermal interface material 910 melts and wets sufficiently the back side 940 and the heat sink 600 to provide sufficient thermal coupling between the heat-producing component 130 and the heat sink 600. In a typical wave soldering machine, the thermal interface material 910 will be exposed to temperatures of more than 70^0C for a period of 15 to 25 seconds over the pre-heaters, and further the thermal interface material 910 is exposed to temperatures above 80^0C for a period of 8-12 seconds when passing over a solder wave in the wave soldering machine. This is generally sufficient to melt the

thermal interface material 910 and wet the back side 940 and the heat sink 600 to produce the necessary thermal coupling between the heat-producing component 130 and the heat sink 600. The above-mentioned exposure times and temperatures can be easily changed/adjusted in a typical wave-soldering machine to suit the requirements of a particular process.

The paragraph beginning at page 7, line 7.

Action 1110, as shown in Figure 11, includes attaching the heat sink 600 in a fixed position onto the heat-producing component 130 and the substrate 140 by soldering the at least one mounting pin 510 to the substrate 140 while the thermal interface material 910 is still hot. In some embodiments, attaching the heat sink 600 in a fixed position includes placing the heat sink 600 in a fixed position onto the heat-producing component 130 and the substrate 140 by soldering the at least one mounting pin 510 to the substrate 140 to form solder joints 1120. Soldering the mounting pins 510 locks in the thermal coupling established by the wetting of the thermal grease 910 during the preheating to provide a low-cost thermal solution to the heat-producing component 130. In some embodiments, soldering the mounting pins 520 onto the substrate includes wave soldering the at least one mounting pin 510 to the substrate 140 to mechanically attach the heat sink 600 to the substrate 140.

The paragraph beginning at page 7, line 19.

Action 1210, as shown in Figure 12, includes cooling the soldered mounting pins 510 to mechanically fix the heat sink 600 in place to form the solder joints 1120 and to further lock in the thermal coupling established between the back side 940 of the heat-producing component 130 and the heat sink 600 while the thermal interface material 910 is still hot.

The paragraph beginning at page 7, line 24.

Figures 13, 14, and, 15 illustrate a top view 1300, a side elevational view 1400, and a front elevational view 1500, respectively, of an electronic assembly including assembled substrate 140 and heat sink 500 thermally bonded to heat-producing component 130 using the

process described with reference to Figures 9, 10, 11, and 12. The process of coupling the heat sink 500 to the heat-producing component 130 according to embodiments of the present invention is described in more detail with reference to Figures 9, 10, 11, and 12. It can be envisioned that more than one heat-producing component can be sandwiched between the substrate 140 and the heat sink 500 and further the heat sink 500 can be thermally bonded to more than one heat-producing component using the process described with reference to Figures 9, 10, 11, and 12. Although not shown in Figures 13, 14, and 15, it can be envisioned that an air movement device, such as a fan, can be mounted on the heat sink 500 to further enhance heat dissipation from the heat sink 500. In some embodiments, the heat-producing component 130 is an integrated circuit device such as a chipset, a microprocessor, a digital signal processor, and/or an application-specific integrated circuit device.

The paragraph beginning at page 8, line 9:

Figures 16 and 17 illustrate the coverage/wetting of thermal interface material between a heat sink 500 and a heat-producing component 130 after passing through wave soldering pre-heaters. Figure 16 illustrates a view 1600 of the thermal interface material coverage 1620 on the underside of heat sink 500 after passing through the wave soldering pre-heaters. Also shown in Figure 16 in dotted line is the outline of the original thermal interface material 1610 disposed between the heat sink 500 and the heat-producing component 130 before passing through the wave soldering pre-heaters. Figure 17 illustrates a view 1700 of the thermal interface material coverage 1710 on the top side of heat-producing component 130 after passing through the wave soldering pre-heaters. It can be seen from Figures 16 and 17 that the thermal interface material 910 (refer to Figures 9-12) has completely wet the heat-producing component 130, and that the thermal interface material coverage 1620 and 1710, respectively, on the heat sink 500 (Figure 16) and on the heat-producing component 130 (Figure 17) has spread beyond the dashed outline of the originally disposed thermal interface material 1610 after passing through the wave soldering pre-heaters in a typical wave soldering machine.

The paragraph beginning at page 8, line 23.

The above-described method and assembly provide, among other things, a low-cost thermal solution by thermally coupling a heat-producing component with a heat sink during a pre-assembly operation.

Clean Version of Pending Claims

ELECTRONIC ASSEMBLY WITH SOLDERABLE HEAT SINK AND METHODS OF MANUFACTURE
Applicant: George Hsieh
Serial No.: 09/897,320

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1. (Once Amended) An electronic assembly comprising:

a substrate;

a heat sink having at least one mounting pin; and

at least one heat-producing component attached to the substrate, wherein the heat sink is disposed over the at least one heat-producing component and the substrate, wherein the heat-producing component is sandwiched between the substrate and the heat sink, wherein a thermal interface material is disposed between the heat sink and the heat-producing component to bond the heat sink to the heat-producing component, and wherein the at least one mounting pin of the heat sink is soldered to the substrate.

2. (Once Amended) The electronic assembly of claim 1, wherein the substrate further comprises:

at least one mounting hole to receive the at least one mounting pin, wherein the at least one mounting pin is disposed in the at least one mounting hole and wave-soldered to attach the heat sink to the substrate and to preheat and bond the heat sink to the heat-producing component with the disposed thermal interface material.

3. (Once Amended) The electronic assembly of claim 2, wherein the heat sink further comprises:

a thermally conductive plate, wherein the heat-producing component has front and back sides, the front side being disposed across from the back side, wherein the thermally conductive plate is coupled to the back side and the substrate is attached to the front side, wherein the at least

one mounting pin extends beyond the thermally conductive plate and the at least one mounting hole.

4. (Once Amended) The electronic assembly of claim 3, wherein the heat sink further comprises:

a heat exchange portion, wherein the heat exchange portion extends beyond the thermally conductive plate and is disposed across from the heat-producing component.

5. (Once Amended) The electronic assembly of claim 4, wherein the heat exchange portion comprises:

multiple fins extending away from the thermally conductive plate.

6. (Once Amended) The electronic assembly of claim 3, wherein the thermal interface material is disposed between the heat sink and the back side of the heat-producing component.

7. (Once Amended) The electronic assembly of claim 6, wherein the thermal interface material is selected from the group consisting of a phase change thermal interface material and a thermal grease.

8. (Once Amended) The electronic assembly of claim 3, wherein the substrate is electrically and/or mechanically attached to the front side of the heat-producing component.

9. (Once Amended) The electronic assembly of claim 1, wherein the heat sink is made from a material selected from the group consisting of copper and aluminum.

10. (Once Amended) The electronic assembly of claim 1, wherein the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.

11. (Once Amended) The electronic assembly of claim 1, wherein the substrate is a printed circuit board.

12. (Once Amended) The electronic assembly of claim 2, wherein the at least one mounting pin is disposed in the at least one mounting hole and wave-soldered during a pre-assembly operation.

13. (Once Amended) A method comprising:

mounting a heat-producing component to a substrate;

positioning a layer of thermal interface material onto the heat-producing component component and the heat sink, and further the at least one mounting pin is disposed over the substrate for soldering the at least one mounting pin to the substrate;

reducing the viscosity of the thermal interface material by preheating the thermal interface material in a pre-heater of a wave soldering machine to cause the thermal interface material to wet the heat-producing component to thermally couple the heat sink to the heat-producing component; and

attaching the heat sink in a fixed position on the heat-producing component and the substrate by soldering the at least one mounting pin onto the substrate.

14. (Once Amended) The method of 13, wherein reducing the viscosity of the thermal interface material comprises:

loading the substrate including the heat-producing component, thermal interface material, and the heat sink onto a conveyor of the wave soldering machine; and

preheating the thermal interface material using the preheater to cause the thermal interface material to wet the heat-producing component.

15. (Once Amended) The method of claim 14, further comprising:

cooling the at least one mounting pin to mechanically fix the heat sink in place.

16. (Once Amended) The method of claim 13 wherein, in mounting, the substrate comprises:

at least one hole to receive the at least one mounting pin of the heat sink.

17. (Once Amended) The method of claim 16, wherein soldering the at least one mounting pin onto the substrate comprises:

disposing the at least one mounting pin of the heat sink through a corresponding at least one hole in the substrate; and

wave soldering the at least one mounting pin to the substrate.

18. (Once Amended) The method of claim 13, further comprising:

forming the heat sink including a thermally conductive plate such that the at least one mounting pin extends beyond the thermally conductive plate.

19. (Once Amended) The method of claim 18, wherein forming the heat sink further comprises:

forming a heat exchange portion such that the heat exchange portion extends beyond the thermally conductive plate and across from the heat-producing component.

20. (Once Amended) The method of claim 19, wherein forming the heat exchange portion comprises:

forming multiple fins extending away from the thermally conductive plate.

21. (Once Amended) The method of claim 13 wherein, in aligning, the heat sink is made from a material selected from the group consisting of copper and aluminum.

22. (Once Amended) The method of claim 13 wherein, in positioning, the thermal interface material capable of melting at a wave soldering preheat temperature is selected from the group consisting of a phase change thermal interface material and a thermal grease.

23. (Once Amended) The method of claim 13, wherein mounting the heat-producing component to the substrate comprises:

electrically and/or mechanically coupling the heat-producing component to the substrate.

24. (Once Amended) The method of claim 13 wherein, in mounting, the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.

25. (Once Amended) A method comprising:

mounting a heat-producing component onto a substrate having at least one mounting hole therein;

aligning a heat sink having at least one mounting pin to the substrate, with the at least one mounting pin inserted into the at least one mounting hole;

positioning a thermal interface material between the heat-producing component and the heat sink; and

using a wave soldering process to cause the thermal interface material to wet and bond the heat sink and the heat-producing component and to solder the at least one mounting pin to the at least one mounting hole.

26. (Once Amended) The method of claim 25, further comprising:

forming the heat sink to have a thermally conductive plate, wherein the at least one mounting pin extends beyond the thermally conductive plate.

27. (Once Amended) The method of claim 26, wherein forming the heat sink further comprises:

forming a heat exchange portion that extends beyond the thermally conductive plate and is disposed across from the heat-producing component.

28. (Once Amended) The method of claim 27 wherein, in aligning, the heat sink is made from materials selected from the group consisting of copper and aluminum.

29. (Once Amended) The method of claim 25 wherein, in positioning, the thermal interface material capable of melting at a wave soldering preheat temperature is selected from the group consisting of a phase change thermal interface material and a thermal grease.

30. (Once Amended) The method of claim 25 wherein, in mounting, the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.